MONTHLY WEATHER REVIEW,

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(General Weather Service of the United States.)

WAR DEPARTMENT,

Office of the Chief Signal Officer,

DIVISION OF

TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE AND AGRICULTURE.

INTRODUCTION.

In preparing this REVIEW the following data, received up to July 13th, have been used, viz the regular tri-daily weather charts, containing the data of simultaneous observations taken at 139 Signal Service stations and 14 Canadian stations, as telegraphed to this office; 147 monthly journals and 159 monthly means from the former, and 14 monthly means from the latter; reports from 24 Sunset stations; 221 monthly registers from Voluntary Observers; 41 monthly registers from United States Army Post Surgeons; Marine Records; International Simultaneous Observations; monthly reports from Voluntary Observers in, and the local Weather Service of, Missouri; reliable newspaper extracts; special reports.

BAROMETRIC PRESSURE.

The general distribution of the atmospheric pressure, as reduced to sea-level, for the month of *June*, 1880, over the United States and Canada is shown by isobaric lines on chart No. II. At a few outlying stations the barometric means are given in figures (English inches.) The region of greatest pressure (over 30.05 inches) includes the South Atlantic and East Gulf States, while the least pressures (below 29.80) are found at Pembina, Omaha and along the eastern slope of the Rocky Mountains from Nebraska to the interior of Texas.

Departures from the Normal Values for the Month.—As compared with the average of the means for the months of June for the past eight years, those for the present month (June, 1880) show a remarkable uniformity. East of a line running along the Mississippi valley from Louisiana to Missouri and thence northeastward to Alpena, Mich., except at Wood's Holl, Portland and Eastport, on the eastern coast of New England, the departure is slightly above the normal. It amounts to 0.05 inch at Cincinnati, 0.04 at Nashville, and less than the latter amount elsewhere. Along the immediate eastern coast of New England and west of a line drawn as above, the departure is below the normal and amounts to only 0.03 inch at Wood's Holl, Escanaba, Davenport, Santa Fé, Cheyenne and Pembina, 0.04 at Omaha and Virginia City, and 0.05 at North Platte, Denver and Salt Lake City.

Barometric Ranges.—The local barometric range, as reduced to sea-level, is marked by great irregularity over the United States east of the Rocky Mountains. Along the Gulf coast it is very small, amounting to 0.24 inch at Key West, 0.29 at Punta Rassa and 0.31 at New Orleans. From these stations northward to Iowa, Wisconsin, Michigan, Ohio, Virginia and North Carolina there occurs a rapid increase in the range, which at Omaha amounts to 1.15 inch; Des Moines, 1.29; Madison, 1.26; Marquette, 1.19; Grand Haven, 1.08; Cleveland, 0.78; Lynchburg, 0.71, and Charlotte, N. C., 0.70. North and westward of the region of greatest range, namely, Iowa and Wisconsin, a rapid decrease occurs, and at Pembina and Cheyenne the ranges are 0.61 and 0.49, respectively. Over Pennsylvania, Maryland and Delaware the range is comparatively small (0.60 inch at Washington, D. C.), but thence northeastward it increases to 0.90 at Boston and 0.91 at Eastport, Me.

Areas of High Pressure.—Apart from the general and permanent area of high pressure which, during June, prevails over the South Atlantic slope, but three different areas of high pressure have been sufficiently marked to merit description. Nos. I and II are the usual outflows of cold, dry air southeastward from the Saskatchawan region, while No. III appears to have been an encroachment of the high pressure of the Pacific Ocean.

No. I.—This area, central the morning of the 1st in the Lower Missouri valley, moving slowly eastward, covered the Ohio valley and Lower Lake region during the 2nd, and the Atlantic States during the 3rd. On the morning of the 4th the highest pressure of the area was reported from the Canadian Maritime Provinces; Father Point barometer, 30.31, or 0.45 above the normal. During the 5th and 6th the area gradually withdrew eastward in advance of low area No. II. After the passage of low area No. II the pressure increased in the Canadian Maritime Provinces and covered those provinces, New England and the Middle Atlantic States, until the 10th, after which it dissipated. Except in the Gulf and a portion of the South Atlantic States, the passage of the area was marked by the minimum temperatures of the month for the entire country east of the Rocky Mountains. Frost was reported from scattering stations in Dakota, Nebraska and Wisconsin during the 1st; from New York, 2nd to 4th and Pennsylvania, 4th. Cautionary Off-shore Signals were displayed from afternoon till midnight of the 1st, from Boston southward to Chincoteague, Va., and Cautionary Signals along the Carolina coast from the 1st to the 3rd, and on the Virginia and New Jersey coasts during the 2nd. The signals—at a few stations somewhat late—were generally justified. The following maximum wind velocities were reported: Barnegat, N. 35; Chincoteague, NE. 35; Delaware Breakwater, N. 42, and Kittyhawk, NE. 44.

No. II.—From midnight of the 14th until the morning of the 16th the pressure steadily increased in the Northwest, the maximum pressure of the area occurring at the latter date at Duluth—barometer 30.28, or 0.36 above the normal. The centre of the area, with nearly unchanging pressure, remained in the Lake region from the 16th to the 19th, while the pressure in the Atlantic States rose considerably above the normal during that time. The area gradually dissipated during the 20th and 21st. During the continuance of this area the minimum temperatures of the month occurred at most stations in the Gulf and at many in the South Atlantic States. The signals ordered in the Lake region for low area No. VI remained displayed (except on Lake Superior) in connection with this area until midnight of the 15th, when they were lowered, having been fully justified, as shown elsewhere.

No. III.—During the 18th this area appeared on the California coast, and gradually moving northeastward during the 19th covered the entire Pacific slope, and extended eastward into the Plateaux districts. During the 20th it slowly dissipated. On the morning of the 20th frost, destructive to vegetation, was reported at Boise City, Idaho; frost and ice at Winnemucca, Nev., and at Yreka, Cal., crops and fruit were badly injured by heavy frost, while ice formed in places. The highest pressure occurred at Red Bluff, Cal., the afternoon of the 19th; barometer 0.36 above the normal.

Areas of Low Pressure.—Thirteen areas are described, ten of which have been charted. No area has been charted entirely across the continent. The areas have been generally ill-defined and of but little energy. No. II and VI are the only areas which crossed any portion of the country with well-defined centres. No. II was a storm of unusual violence and duration for June.

No. I.—This area, a continuation of No. X of the May REVIEW, during the 1st passed from the St. Lawrence valley eastward over the Atlantic Ocean.

No. II.—During the 2nd and the morning of the 3rd the pressure gradually decreased on the northern Rocky Mountain Slope; on the afternoon of the latter day the barometer at Fort Keogh was 0.27 below the normal. Moving southeastward, the area was central the afternoon of the 4th in the Lower Missouri valley; Omaha barometer 29.25, or 0.50 below the normal. During the preceding eight hours an abnormal barometric fall of over 0.10 inch occurred over the greater part of the Lower Missouri and Upper Mississippi valleys, while exceedingly heavy rains fell in Minnesota. During the day violent local storms occurred as follows: at St. Louis one person was killed, several buildings blown down and much damage to property done, both in the city and south of it; the wind attained a velocity of S. 52 miles at 11 a. m. in St. Louis. At and near Milwaukee the wind attained a velocity of SW. 60 miles at 2.30 a. m. Three vessels were dismasted a short distance outside the harbor and several others damaged in canvas and spars. From that afternoon until the afternoon of the 5th the centre remained stationary in the Lower Missouri valley, with steadily decreasing pressure; Omaha barometer at latter date 29.05, or 0.71 below the normal. During the preceding twenty-four hours, brisk southerly winds, high temperatures and heavy rainfalls prevailed in the Upper Mississippi valley, while to the westward and northward of the Lower Missouri valley, high northerly winds, low temperatures and heavy rainfalls were reported. At Omaha, at 6 p. m. of the 5th, the barometer touched 28.85—its lowest point—and half an hour later the wind veered suddenly from SW. to NW., and reached a velocity of 60 miles. At midnight of the 5th the storm was central in eastern Missouri; Des Moines barometer 28.97. Moving northeastwardly, on the afternoon of the 6th the central area was in northern Michigan; Escanaba barometer 29.09, or 0.76 below the normal. During the night of the 5th and 6th the storm was unusually severe over Lake Erie and the entire Upper Lake region. Moving from Michigan in a northeasterly course, parallel to the St. Lawrence valley, the central area passed into the Province of Quebec

during the 7th. In connection with the passage of this area occurred exceedingly heavy rainfalls from the 3rd to the 6th, in Wisconsin and northern Michigan, which greatly damaged crops, flooded the country generally, and swept away over fifty million feet of lumber in Wisconsin. Cautionary Signals were ordered for the entire Upper Lake region at noon of the 4th, for Lake Erie the morning of the 5th, and for Lake Ontario the afternoon of the 6th; they were lowered on Lakes Superior and Michigan on the morning of the 6th and later in the day in the rest of the Lake region. These signals were fully justified by unusually high winds from the 4th to the 7th. The following maximum velocities were reported: Duluth, NW. 31; Rochester, W. 32; Alpena, SE. 33; Chicago, W. 36; Grand Haven, SE. 40; Toledo, SW. 42; and Milwaukee, W. 48. During the 5th and 6th Cautionary Signals were displayed along the Atlantic coast from Sandy Hook southward to Cape Lookout. These signals were all justified by maximum velocities ranging from SE. 30 at Sandy Hook, and SW. 30 at Cape Lookout to SE. 39 at Delaware Breakwater.

No. III.—The centre of this area was apparently on the coast of British Columbia on the morning of the 7th, at which time the barometer at Olympia was 29.74, or 0.34 below the normal. The advance of this area produced general rains in the North Pacific Coast region during the 6th and 7th. Following a course a little S. of E., its centre on the afternoon of the 8th was in Dakota; Fort Buford barometer 0.47 below the normal. Changing its course northeastward, by the morning of the 9th it had passed into Manitoba

No. IV.—This area appears to have sprung up from the remains of area No. III. As the central part of that area passed northeastward into Manitoba during the night of the 8th, a considerable area of depression existed in the Middle Rocky Mountain region, where it remained—nearly unchanged—until midnight of the 10th, when a sharp barometric fall occurred in Colorado; Denver barometer 0.35 below the normal. During the 11th it passed northeastward, and by midnight was in the valley of the Red River of the North. Thence moving in an easterly course across the Lake region, it merged during the 13th with the remains of low area No. V, and formed an extensive area of low pressure which covered the Atlantic slope from North Carolina to Nova Scotia, the pressure along the immediate coast from New England northward being 0.50 below the normal. During the 14th the area moved eastward over the Atlantic Ocean. No signals were displayed in connection with the passage of this area. During the 12th and 13th frequent cases of high winds were reported from the Lake region and the Atlantic coast from North Carolina northward.

No. V.—In the afternoon of the 11th a sharp barometric fall was reported from New England and the St. Lawrence valley, at which time the area was apparently central in the Province of Ontario. On the morning of the 12th the area was central in New Brunswick; Eastport barometer 0.34 below the normal. During the 12th the pressure steadily decreased in New England and the Canadian Maritime Provinces; Sydney barometer, the morning of the 13th, 0.50 below the normal. The subsequent description of this area is given as that of No. IV, with which it united on the 13th. No signals were displayed and no dangerous winds reported in connection with this area.

No. VI.—During the 13th the pressure decreased slowly in the Lower Missouri valley, forming a decided depression by the morning of the 14th, when the Leavenworth barometer stood at 29.50, or 0.35 below the normal. Moving directly eastward the centre was in the Mississippi valley that afternoon—St. Louis barometer 0.37 below the normal—and by midnight reached southwestern Ohio. During the 13th and 14th, in connection with this area and advancing high area No. II, heavy rainfalls occurred in the greater part of the Upper Mississippi and Ohio valleys, causing numerous local floods and doing great damage to crops. Central the morning of the 15th in West Virginia, it moved thence southeastward and during that night passed off the North Carolina coast over the Atlantic Ocean. During the afternoon of the 13th Cautionary Signals were ordered for the Upper Lake region, and during the 14th for Lake Erie. The following maximum wind velocities were reported: Detroit, SW. 28; Toledo and Chicago, NE. 32; Milwaukee, NE. 34; Sandusky, NE. 37. On the morning of the 14th Cautionary Signals were displayed along the Atlantic Coast from Cape Lookout northward to Sandy Hook. They were all justified by maximum wind velocities ranging from E. 25 at Atlantic City and NW. 28 at Cape May to NE. 35 at Delaware Breakwater, NE. 40 at Cape Lookout and NE. 44 at Kittyhawk.

No. VII.—During the 20th the pressure fell steadily over the St. Lawrence valley, where this area was central at midnight of the 20th. Moving slowly southeastward through Maine during the 21st, it passed off the Nova Scotia coast the afternoon of the 22nd, at which time Halifax barometer stood at 29.52, or 0.38 below the normal. During the 21st and 22nd northwesterly winds, ranging from 26 to 40 miles, were reported from various stations on the New England and New Jersey coasts. No signals were displayed during the passage of this area.

No. VIII.—From midnight of the 21st until the morning of the 24th, an ill-defined area of low pressure prevailed over Louisiana and southern Texas, disappearing on the latter date. Its centre was probably in the western part of the Gulf of Mexico. The only high wind—probably local—reported, was E. 29 at New Orleans, the afternoon of the 22nd. No signals were necessary, and none were ordered, during the passage of this area.

No. IX.—This area gradually developed in northern Minnesota or Manitoba during the 22nd. Mov-

ing in an easterly course it passed over Lake Superior during the 23rd, and was central the morning of the 24th in Ontario, whence by a southeasterly path it passed off the Maine coast at midnight of the latter date. No signals were displayed during its passage. The area was one of but little energy; high winds (from 25 to 27 miles) occurred only at three widely separated stations in the Lake region.

No. X.—During the 23rd the pressure steadily decreased on the North Pacific coast. On the morning of the 24th the barometer at Portland, Or., was 0.23 below the normal. The pressure remained slightly below the normal until the 30th. During the prevalence of this area no rain fell on the Pacific coast.

No. XI.—Apparently central at midnight of the 23rd in Manitoba the centre of this area moved southeastward and remained over the Lake Superior region during the 24th. Central the morning of the 25th in northern Michigan, it reached the valley of the St. Lawrence by midnight, and passing down that valley it disappeared over the Gulf of St. Lawrence on the 26th. No signals were displayed during the passage of this area. But four cases of brisk winds, at widely separated stations, were reported during its passage.

No. XII.—This area, central in Manitoba the morning of the 26th, reached eastern Minnesota at midnight. Moving slowly in an easterly course, it was central over the Upper Lake region until the 28th, on the afternoon of which day it reached the province of Ontario and thence passed down the valley of the St. Lawrence. Brisk SW. winds, ranging from 26 to 30 miles, were generally reported from the Lower Lake region on the 28th, On the Atlantic coast Cautionary Signals were ordered on the afternoon of the 28th from Portland, Me., to Chincoteague, Va. The signals were lowered the next morning, having been justified by velocities ranging from SW. 26 at Barnegat, to N. 29 at Cape May, and SW. 31 at Thatcher's Island.

No. XIII.—From midnight of the 29th the pressure fell from Kansas to Texas until midnight of the 30th, at which time the barometer at Dodge City was 0.19 below the normal.

INTERNATIONAL METEOROLOGY.

Three International Charts, Nos. IV, V and VI, accompany the present REVIEW. They are for the months of *May*, 1880, and *October*, 1878.

On Chart No. IV will be found the probable course of the principal low pressure areas over the North Atlantic Ocean during the month of May, 1880. As during the preceding month (*April*, 1880) the weather over the North Atlantic has continued remarkably fine and free from severe or protracted storms. The month opened with a belt of high pressures extending over Europe, from the Black Sea to the British Isles and France, and thence over the Atlantic to Newfoundland and the Bermudas: on the 1st, over the western portion of the Atlantic, barometric readings above 30.40 in. or 772.1 mm., were reported over a region extending from 50° N. 25° W. to 35° N. 53° W. Ship *Hippolyta*, in 42° N. 45° W., on the southeastern margin of this ridge of high pressures, reported, during the night of April 30th and May 1st, a very heavy N. to E. gale, with high sweeping sea: from 2 to 3 a. m. the gale was furious, force 11, but moderated towards daybreak. From the 1st to the 11th this area of maximum pressures appears to have moved northeastward, with more or less regularity, and on the latter date to have covered northwestern Europe and the Atlantic for some distance to the westward, over which latter region high pressures continued until the 17th, and caused the continued northeasterly winds which prevailed during this period (10th to 17th) over the Eastern Atlantic near the parallel of 50° N. The first protracted storm of the month followed the track shown on the present chart as area No. I, and was fully described as low area No. I in the May REVIEW. On the 7th it passed eastward over Newfoundland, and on the 8th was encountered by S. S. *Nederland* in 43° N. 42° W., barometer 29.86 or 758.4, temperature 62° Fahr., wind SSW., force 4, high SSW. sea. On the 9th it was followed over this region by a return to high pressure and a rapid fall in temperature; the *Nederland*, in 41° N. 47° W., reported barometer 30.19 or 766.8, temperature 46° Fahr., NNW. 2. It is probable that this low area remained during the 9th and 10th near 50° N. 40° W., and is the same as that to be described as area No. IV, but reports at present to hand do not warrant the joining of the two tracks. The second storm (No. II, Chart IV,) apparently developed off the coast of Portugal on the 4th, and subsequently moved eastward over the Mediterranean. On the 8th a small depression (No. III, Chart IV,) was central to the southwest of Ireland, which subsequently moved southeastward over the Bay of Biscay and southern France. Ship *Hippolyta* reported, "on the 8th, in 49° N. 15° W., 8 p. m., strong NE. gale, force 11, and high cross-sea; midnight (8th–9th) gale moderating." No. IV appeared over mid-ocean on the 11th. On the 12th and 13th, U. S. S. *Saratoga*, near the Azores, recorded the following very low pressures for this region: 12th, 39° N. 24° W., 29.43 or 747.5, calm, heavy rain-squalls; 13th, 39° N. 20° W., 29.49 or 749.0, WSW. force 7, fair. On the 14th, the easterly winds on the northern margin of this area increased in force and S. S. *Indiana*, in 51° N. 15° W., recorded ESE. 8, barometer 29.89 or 759.2. On the 16th, the barometer at the Madeiras (Funchal) read 29.61 or 752.0, and from the 17th to the 21st this area appeared to spread eastward over the Mediterranean to the Black Sea region. No. V is a continuation of low area No. IV, already described in the May REVIEW; on the 14th, S. S. *Scythia*, in 41° N. 59° W., reported barometer 29.67 or 753.6, wind NNW. 4, light rain, and on the 16th, in 44° N. 45° W., 29.35 or 745.4, WSW. 9, heavy rain, heavy swell from WSW. High winds, occasionally described as of hurricane force, were experienced over the western portion of the Atlantic during the 15th and 16th, but by the 17th only moderate gales. During the 18th and 19th there was a gradual return to high pressures, and very low temperatures were recorded; thus, on board the S. S. *Hibernian*, the thermometer fell from 40° F. on the 17th, in 49° N. 39° W., to